

EMERGING ISSUES

Sentinel Detection Methods and Health Risk Assessment of Building Chemical Decontaminants: Key Components of EPA's Safe Building Program

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1. USE OF SPECIALLY RAISED SENTINEL ANIMALS INDOORS

Background

- Detection of unknown toxic agents in the air of public buildings is a critical need.
- Electronic detection methods are subject to interferences.
- Sentinel animals are used in military applications.
- Canaries have traditionally been used in mines and they were used in Tokyo subways.
- Use of canaries is based on very limited information (Burrell, 1912).
- Several studies have used outdoor wild sentinels, however, few address indoor sentinels.

Purpose

- Improve detection of unknown chemical threats in indoor environments.

Scientific Approach

- Create a working group of qualified investigators.
- Search available scientific literature.
- Meet for the purpose of providing immediate written guidance on the use of sentinel animals indoors.
- Determine research needs from literature and input from investigators.
- Implement research to fill data gaps which could include:
 - Improving biomarkers of exposure.
 - Making pharmacokinetic comparisons between humans and sentinels (see oxygen figure).
 - Comparing sensitivity of sentinels with that of electronic equipment.
 - Improving collection and use of data on indoor sentinels.
 - Engineering plans for sentinel housing in public places.

PIGEONS USED AS SENTINELS IN THE RECENT GULF WAR



Source, CNN News, March 2003

Oxygen Consumption Comparison: Why Some Species Might Be More Susceptible to Air Pollutants

SPECIES	O ₂ consumption, ml/ gram body wt.
Resting human	0.2
Resting mouse	1.6
Flying pigeon	12
Hummingbird	30
Bumblebee	60

THE EARLY STUDY DOCUMENTING USE OF CANARIES IN MINES:

Shows Carbon Monoxide Percentages In Air and Times to Disablement

Species	No Effect Level	Visible Distress "comment"	Disablement "comment"
Man	0.6 % 20 min	0.1% 20 min "giddiness"	0.1% 150 min "collapse"
Mouse	0.6% 2 min	0.6% 6 min "sluggish"	0.46% 6 min "collapse"
Canary	0.12% 15 min	0.15% 3 min "sways on perch"	0.2%, 5 min "jumps off perch to floor"

Source: Burrell, George A . The use of mice and birds for detecting carbon monoxide after mine fires and explosions. US Bureau of Mines. 1912

PUBLIC HEALTH RISK ASSOCIATED WITH CHEMICAL DECONTAMINATION

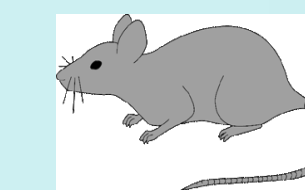
Experimental Design

In Vitro ClO₂ Toxicity

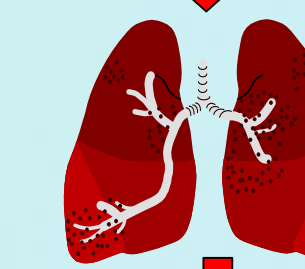


Human airway cells will be exposed to ClO₂ at and below OSHA REL. Toxicogenomic analysis will be performed on isolated RNA.

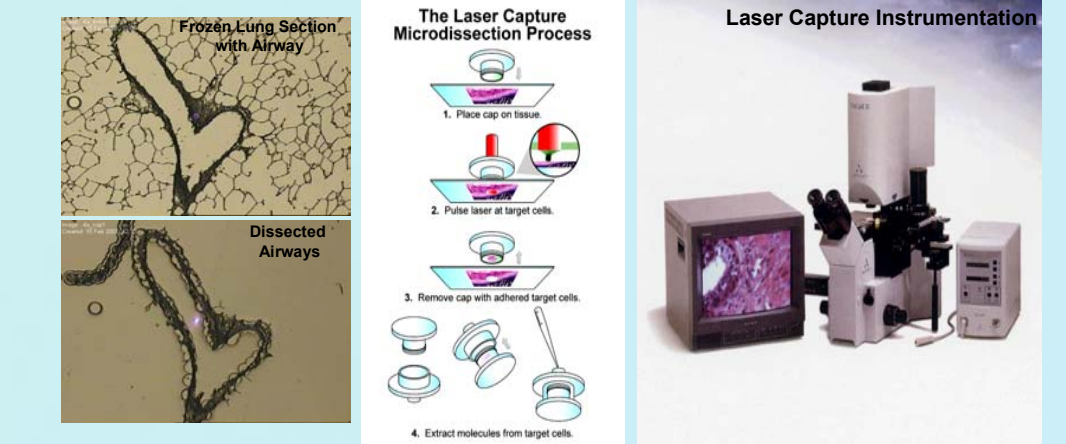
In Vivo ClO₂ Toxicity



Animals will be exposed to ClO₂ at and below the OSHA REL.



Histopathology will be performed for evidence of injury. In addition, frozen lung sections will be obtained for airway micro-dissection and toxicogenomic analysis.



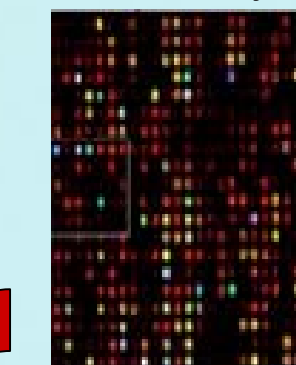
Laser capture microdissection will be used to isolate airways from ClO₂ exposed animals. RNA will be isolated from dissected airways

RNA, Proteins

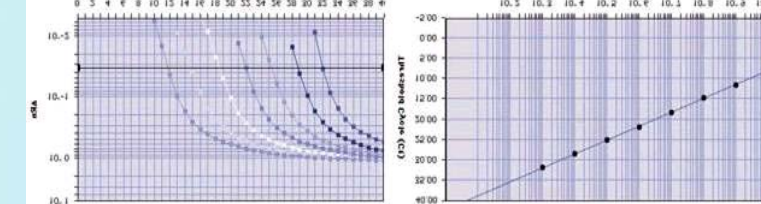
Dosimetry: Mass spectrometric measurement of OXYGEN-18

Toxicogenomics

DNA microarrays

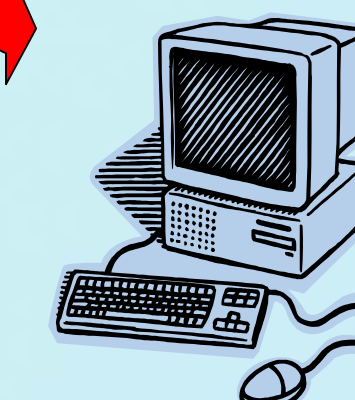


Real Time Quantitative RT-PCR



Gene expression profiling will be conducted use cDNA microarrays containing several thousand genes to provide a sensitive and comprehensive assessment of potential adverse health responses following acute exposure to low levels of ClO₂. Quantitative real time RT-PCR will be used to confirm DNA microarray results.

Bioinformatics



Computer analysis of DNA microarray data will identify genetic responses that are indicators or biomarkers of airway:

- Injury and Remodeling
- Cancer
- Inflammation (Bronchitis)
- Allergic or asthmatic like alterations

Environmental Issue

Decontamination of buildings with chemicals, such as chlorine dioxide (ClO₂) currently in use to kill anthrax spores, has demonstrated our limited knowledge regarding potential health risks associated with public exposure to low levels of chemical fumigants during removal or when decontaminated buildings are release for re-occupancy. The OSHA recommended exposure limit (REL) for ClO₂ is currently being employed as default "safe" level for building re-occupancy. However, this standard is based upon limited accidental, and dated information regarding the health effects of acute ClO₂ exposure. Contemporary comprehensive toxicological information on the health effects associated with low level exposures to ClO₂ is needed for environmental clearance committees to make sound decisions on when to reoccupy decontaminated buildings.

Scientific Approach

In vitro and *in vivo* toxicological and toxicogenomic and dosimetric studies as depicted in the Experimental Design will be conducted to assess the acute health responses following exposure to levels of ClO₂ at and below the OSHA REL. ClO₂ dosimetry will involving labeling with oxygen-18 (shown in purple).

Impact of Studies

This study will provide a contemporary, sensitive, and comprehensive assessment of the acute health effects associated with exposure to low levels of chlorine dioxide. This information will be extremely useful for the following customers:

- OWSER; decontamination/waste removal personnel;
- Building environmental clearance committees;
- OPPTS, US EPA